Istra Road Administration, Maintenance Development Plan

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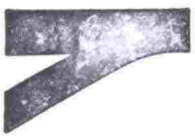

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Summary

According to the co-operation agreement between the Russian Federal Highway Department and Finnish National Road Administrations, a report on the development on road maintenance services has been drawn up in respect of two region road administration (Avtodors) in the Moscow Regional Highway Department (Mosavtodor). Kolomna and Istra were chosen as the Avtodors. Istra is located about 40 kilometres (km) west of Moscow between road M-10 to Finland and M-9 to Riga. At Istra the conditions for the adoption of new methods, techniques and administrative systems are favourable. The road network in the Istra region covers a distance of about 285 km. The resources have been calculated for about 300 km of road. If the road network were larger, more ploughing equipment in particular would be required.

In the present assignment, recommendations were made as to what a Avtodor should look like in its target state of maintenance, in which the target quality of the road network is achieved as efficiently and economically as possible. In this context maintenance primarily refers to the servicing of roads, especially during the winter season.

The target state of maintenance implies new maintenance machinery and a fleet of motor vehicles and their equipment, new working methods, new quality objectives, high professional skills of staff, efficient use of materials etc. A new maintenance base will also be built it Istra, the planning of which is beginning as a separate project. Necessary investments in equipment, the base, material storage etc. shall take place after the planning stage, at the actual implementation stage.

The objective is to utilise, where possible, new technology while, at the same time, observing specific local conditions. Local conditions imply, contrary to the Finnish practice, almost complete self-sufficiency, due to a very limited supply by the private sector. In addition, dimensioning etc. have been influenced by the condition and quality of the road network, the nature of traffic and the cost of maintenance work in general as well as its cost structure.

It has been estimated that the new working methods and techniques help to achieve annual savings, thanks to which a full return on the investments required by the development plan will be achieved in 3 to 5 years. In addition, the level of services provided for road users will be improved, and the costs will be reduced through a better quality of servicing of the road network, and improved road safety. Environmental hazards will be reduced by the decreasing use of salt and sand, and by a reduction in fuel consumption.

In addition to new technology, the investment in new working methods means raising the professional skills of employees. Another important task will be the continuous training of drivers, mounters, supervisors and personnel in general. In the development of the road network particular attention shall be paid to improving the longitudinal and crosswise form, on the composition of the asphalt mixture and the quality of the materials, on the drainage system and the paving of shoulders.

The development plan may also be applied elsewhere to road networks managed by Mosavtodor or the Federal Highway Department.

Foreword

The development plan of Istra Avtodor is intended to boost the maintenance of the road network in the Istra region by using new technology, new working methods and equipment. The development plan also serves as a model for the whole Mosavtodor and even beyond it in Russian territory. A similar development plan has been drawn up for the Kolomna Avtodor.

The development plan is, for its part, a contribution towards the development of a more comprehensive road maintenance control system. The system is needed for a more effective utilisation of servicing and repair resources, achieved by means improving administration and technical skills, and for the development of economic criteria based on the needs of road-user, and for organising effective monitoring of maintenance costs. There are three alternatives for the organisation of the regional maintenance services:

- the existing system, in which projects are given to a contractor
- a state-controlled maintenance system consisting of regional road authorities, model Kolomna
- the rights of the regional road authorities are extended to include the financing of projects and contracting, model Istra.

The management of maintenance work means the management of projects (strategy, financing), management of contracts (tenders, appointment of contractor, estimation and definition of workload and quality, etc.) and the management of work assignments. This development plan defines the criteria for some aspects of the management of the assignments.

The development plan is based on the co-operation agreement between the Russian Federal Highway Department and the Finnish National Road Administration, and it has been drawn up as a joint project between Mosavtodor and the Finnish Road Administration. The membership of the working group drawing up the plan was as follows:

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Istra, October, 1994

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1. THE PRESENT STATE OF THE ROAD NETWORK AND MAINTENANCE

1.1. Organisation

There is a straightforward purchaser-supplier set-up in Istra. The purchaser is Istra Avtodor (Istrinskij Raion) belonging to Mosavtodor. The road maintenance service is purchased from three suppliers, at present Avtodor, Istrador-1 and DCY-5. Avtodor services almost 60 per cent of the road network, and Istrador 35 per cent.

1.2. The road network

Istra Avtodor manages a total of 284 km of roads, most of them with asphalt paved. There are no gravel or macadam roads, and only a good 3 km of so-called dirt road without any wearing course.

The roads are categorised into three maintenance classes, viz. 1, 2 and 3.

Table 1. The Istra road network (km) according to type of surfacing and maintenance class.

		Total.	Maintenance class (Mosavtodor) 1	2	3
Total length (km)		**284,11**	**29,2**	**204,6**	**50,31**
Asphalt concrete					
Pavement	8-10 m	11,5	8,5	3,0	
	7 - 8 m	82,2	7,5	74,7	
	< 7 m	175,3	13,2	123,9	38,2
Concrete	< 7 m	11,7			11,7
Grit surfacing					
Gravel/macadam					
Soil		3,4		3,0	0,4

In *appendix 1* is descriped the location of Istra and in *appendix* 2 the road network road by road. The length, traffic volume (Average Daily Traffic), and the maintenance class, are given in respect of each road. There are 65 roads in all.

The traffic volume of the busiest road is about 3 000 vehicles per day. This road is 13 km long. A traffic volume exceeding 1 000 vehicles per day applies to a total section of road of 140 km.

The traffic volume of the quietest roads is clearly below 200 vehicles per day.

In connection with this project no systematic assessment of the condition of the road network was made.

In addition to the road network inventory, a detailed inventory of the bridges, culverts and other requisites and equipment existing in the road network was made. There are a total of 21 bridges with a combined length

of over 1000 metres. *Table 2* groups the equipment and requisites in accordance with the road classification.

Table 2. Road requisites and devices.

Road equipment and accessories		Total	Class of road (Mosavtodor) I	II	III
Bridges	linear metres each	21/1049	3/245	17/779	1/25
Culverts	linear metres each	343/5677	36/695	262/4476	45/506
Bus stops	qty	233	30	201	2
Bus stop shelters	qty	157	20	136	1
Lay-byes	qty	32	7	25	
Sign post	qty	1869	295	1508	66
Curved timber fence	km	2	1	1	
Rope fence	km				
Pavement	km	34,7	8,9	25,8	
Reinforced verge	km				
Traffic sign	qty	695	165	510	20

The pavements in *Table 2* refer to a type of one-metre wide footpaths that are not cleared of snow in the winter.

1.3. Staff

The total number of maintenance staff in Istra was 120 in 1993. Of that number, 77 are operators of various kinds of machines or drivers, and 13 are maintenance men.

Table 3. Road maintenance personnel (Istraavtodor + Istrador-1).

Road maintenance personnel	Total
Average total	**120**
Maintenance men	13
Machine operators	18
Drivers	59
Skilled artisans	30
- using equipment	20
- in the terrain	7
- at the base	3

The normal working hours are 41 hours per week. The maximum amount of overtime is 120 hours annually.

1.4. Machinery and motor vehicles

The following table shows the present fleet of machinery and motor vehicles.

Table 4. The quantity of maintenance equipment

Road maintenance machinery	Qty
Motor grader	4+2
Bulldozer	3+1
Roller	5+1
Mower	0
Excavator	4+0
KDM machines	12+6
Trucks	24+4

Motor graders and KDM-machines (maintenance truck) are used for the removal of snow and as ice control.

In respect of road transport, work shifts and the quantities of goods are recorded separately.

Table 5. Road transport volumes in 1993.

Road haulage for road maintenance purposes		1993 (actual)
Haulage shifts	qty	600
Road haulage	t	15 000+37 000

1.5. Maintenance tasks

Present maintenance tasks are grouped as follows:

Road structure
- Shoulder
- Ramps
- Lateral ditches
- Drainage

Surface maintenance of asphalt roads and concrete roads
Surface maintenance of grit roads
Surface maintenance of gravel roads
Servicing of the dirt road
Servicing of structures requiring craftsmanship
- Bridges
- Culverts

Servicing of bus stops
Servicing of bus shelters
Servicing of laybyes
Servicing of safety posts
Servicing of safety fences
Servicing of rope fences
Servicing of pavements
Servicing of shoulders
Servicing of traffic signs.

The aforementioned task categories are posted under a total of 94 separate cost items.

The principal tasks are perhaps those related to the care of the asphalt and concrete road surfacing in the winter season. The snow ploughed and ice removed in the year 1993 amounted to about 1.1 km^2. In addition, smooth grading and snow ploughing of the verges totalled 0.2 km^2.

The total volume of anti-skid material spread on the roads was 12,500m^3 in 1993. Assuming that the length of the road network to be sanded is 200 km, about 60 cubic metres per kilometre (m^3/km) of sand will be spread in a year. If the amount spread at one time is 0.5 to 1.0 m^3/km, there are 60 and 120 applications respectively per annum. Salt is added to the sand to prevent freezing and to melt the snow. The salt volume is 100-200 kg/m^3. The sand is stored outdoors.

Disposal of waste and other cleaning and sanitation work, mowing lawns and cutting grass, taking care of the verges, servicing the farm road intersections and traffic signs are the main tasks in the summer season.

1.6. Maintenence base

A new base needs to be built for the road maintenance of the Istra Avtodor. Mainly two alternative locations were available, of which the plot situated on the south-western boundary of the city centre was chosen. It is very well situated with regard to the road network to be maintained.

2. PLAN FOR DEVELOPMENT OF WORKING METHODS

2.1. Maintenance classification

It is recommended that roads be classified according to seven road maintenance classes, following the practices of the Finnish National Road Administration. The classification criteria are traffic volume and quality. For each maintenance class, the level of road maintenance, called condition class, has been defined. The condition classes are:

Table 6. Recommendation for Road Maintenance Classification.

Highway Winter Maintenance Classification

ADT	TRUNK ROADS	MAIN ROADS	REGIONAL ROADS	CONNECTING ROADS
> 12000	Isk	Isk	Isk	Is
6000 - 12000	Is	Is	Is	I
3000 - 6000	I	I	I / Ib	Ib
1500 - 3000	I	Ib	Ib	Ib
500 - 1500	Ib	II	II	II
200 - 500	II	II	II	III
< 200		II	III	III
Pedestrian and Bicycle paths	IV	IV	IV	IV

Bare Pavement Roads
Snow Surface Roads During Cold Winter Conditions
Snow Surface Roads

(See also table:
Target Condition Values and Cycle Time)

Note: Isk = super divided, Is = super undivided,
Ib = thin layer of packed snow allowed

This maintenance classification can be applied to Istra, providing that local conditions are taken into account. One of the underlying principles is that a requirement level be consistently applied to any specific road as a whole, although the traffic volume would not fully justify it.

Appendix 3 contains a proposal for a maintenance classification of the roads.

2.2. Quality standards for winter road maintenance

The proposals are based on the Finnish practices and experiences. A **maintenance target** is defined for each maintenance class, and the road will be maintained accordingly, allowing for the relevant circle time for action and period of application. The roads in Istra fell into maintenance classes I to III. Class IV refers to pedestrian and bicycle ways. No such

actually exist in Istra, only ordinary footpaths that are not maintained in the winter season.

The quality level of shoulders will be determined later.

The targets set for maintenance condition classes are shown in *Table 7* below. The circle time refers to the maximum period from the time a deviation in condition is observed to the complete restoration of the target condition.

Period of application refers to specified times of the day or week when the target condition is required. At other times the condition may drop to the level of the class below. With regard to the slipperiness of roads, target condition 2 is the absolute minimum when the snow cover does not exceed 10 cm, *Table 8* shows the periods of application of target condition.

Table 7. Circle time for winter road maintenance action.

Road maintenance class	Roads in each road maintenance class	Target condition	Circle time Anti-skid treatment	Removal of snow	Removal of slush	Level grading
I sk	Dual carriage ways	4	2 h	2.5 h	2 h	1 day
I s	ADT*>6000	4	2 h	2.5 h	2 h	1 day
I	**ADT>1500**	**4**	**2 h**	**3 h**	**2.5 h**	**1 day**
Ib	**ADT>500**	**4/3**	**3 h**	**3 h**	**3 h**	**1 day**
II	**ADT 200-1500 oil gravel. >200**	**3**	**4 h**	**4 h**	**4 h**	**3 days**
III	**ADT<200**	**2**	**6 h**	**6 h**	**6 h**	**5 days**
IV	Pedestrian and bicycle ways	3	4 h	4 h	4 h	2 days

*ADT = Average daily traffic, vehicles per day.

Table 8. Period of application of target conditions.

Road maintenance class	Period of application of target condition Weekdays	Saturdays	Sundays
I sk and I s	Always applicable	Always applicable	Always applicable
I	6.00 - 24.00	6.00 - 24.00	9.00 - 24.00
Ib	6.00 - 24.00/ cond. 4	6.00 - 24.00/ cond. 4	9.00 - 24.00/ cond. 4
II, III and IV	Always applicable / cond. 3	Always applicable / cond. 3	Always applicable / cond. 3
	6.00 - 22.00	9.00 - 24.00	9.00 - 24.00

Table 9. Target condition levels for winter road maintenance.

	LEVEL OF SERVICE				
Quality class variable	1 Poor	2 Fair	3 Satisfactory	4 Good	5 Excellent
SLIPPERY CONDITION Skid number Road surface texture	0,00-015 Very icy driving or othervise very slippery	0,15-0,25 Dry ice or snow packed	0,25-0,30 Coarse ice or snow packed in cold weather	0,30-0,45 Bare and wet or packed snow between traffic ruts	0,45-1,0 Bare and dry
SNOW CONDITION Dry frozen snow Thawing snow Slush Drifting snow	> 50 mm > 40 mm > 30 mm Easy passage may be difficult in some places, car may become stuck in a snowdrift	< = 50 mm < = 40 mm < = 30 mm Drifting over the road or moderate snow layer at the road edges, driving speed must sometimes be reduced	< = 30 mm < = 25 mm < = 20 mm Drifting here and there over the road, driving speed has to be reduced in some cases	< = 20 mm < = 15 mm < = 10 mm Drifting here and there to the middle of the outermost traffic lane, generally no need to reduce the driving speed	- - - -
EVENNESS Ruts Other roughness	< 30 mm Path very uneven, possible projecting bumps, driving speed must be reduced and uneven spots avoided	< = 30 mm Plenty of worn spots or disturbing holes, driving speed must be reduced in some places	< = 20 mm Path even, possible unevenness does not actually disturb driving	< = 10 mm Thickness of path strips on the road portion under traffic < = 10 mm	- -

Snow removal

Snow removal measures are taken to keep the road free of snow and thus maintain driving conditions in accordance with the target condition. Especially a change from slushy to wet, snowless conditions reduces the risk of accidents.

During a continuous snowfall or after a snowstorm, the flow of traffic is ensured and the target condition is restored within the required circle time.

In cases where the amount of newly fallen snow is less than the permitted amount of snow, the need for snow removal shall be considered on the basis of road safety and the need for smooth grading.

Maintenance classes Isk, Is and I

Snow removal shall be commenced when

- the layer of frost snow is ≥ 20 mm, or
- the layer of wet and sticky snow is ≥ 15 mm, or
- the layer of slush is ≥ 10 mm, or
- the outermost edges of the snowdrifts are, here and there, projecting to a distance of 1,5 m from the borderline or from the

edge of the pavement, but they do not necessitate a reduction in driving speed.

As regards frost snow, the snow removal action may be postponed in the event that snow is moved by the passing traffic to the edges of the carriageway, and the carriageways are snowless. Snow banks between lanes, which severely hamper the changing of lanes are, however, not permitted on the carriageway. If the snow accumulating in the middle and on the sides of the carriageway whirls up with the air currents in the wake of the vehicles, snow removal after the snowfall shall be considered for reasons of road safety, even though it would not otherwise be necessary in terms of the target condition.

Maintenance class II

Snow removal shall be commenced when

- the layer of frost snow is ≥ 30 mm, or
- the layer of wet and sticky snow is ≥ 25 mm, or
- the layer of slush is ≥ 20 mm, or
- the outermost edges of the snowdrifts are, here and there, projecting across the carriageway necessitating a reduction in driving speed.

As regards frost snow, the snow removal action may be postponed, if the traffic moves the snow to the edges of the carriageway, and relatively little snow accumulates on the carriageway. Banks of snow or grading ridges severely hampering the changing of lanes or meeting oncoming traffic are, however, not allowed to accumulate in the middle of the carriageway and at the edges.

Maintenance class III

Snow removal shall be commenced when

- the amount of frost snow is ≥ 50 mm, or
- the amount of wet and sticky snow is ≥ 40 mm, or
- the slush layer is ≥ 30 mm, or
- the outermost edges of the snowdrifts are projecting across the carriageway, and there is snow on the edge of the carriageway necessitating a reduction driving speed in places.

Maintenance class IV

Snow removal aims at reaching target conditions according to Maintenance Class II standards.

The clearing of snow from a lane reserved for pedestrian and bicycle traffic, which is separate from a highway, should follow the same time schedule as that for the highway in order to prevent this traffic from moving over to the highway. If the highway has a separate lane designated for pedestrians and bicycles, it should be cleared of snow immediately after the work on the carriageway has been completed.

Anti-skid treatment

Driving conditions that meet the standards adopted are achieved by means of various measures aimed at preventing the road surface from becoming

slippery or, at least, at making it less slippery. Whenever possible, action should be taken right after the snow has been cleared away.

Spreading salt on the road lowers the risk of accidents, especially when ice formation is imminent. Salt being an environmental hazard, attention should be paid to the quantities of it used. Salt liquid or pre-wetted salt should preferably be used, as these alternatives have a better adhesion to the road than crystallized salt. In the case of roads with a traffic volume exceeding 1 500 vehicles per day, it is recommended that pre-wetted salt should be used.

Sanding tends to reduce the accident risk only under very slippery conditions. It is therefore recommended that roads with a traffic volume of less than 1 500 vehicles per day be sanded. The sand should cover the whole stretch of the road or, alternatively, depending on the weather (i.e. in dry conditions), it might cover only especially problematic sections (such as cross-roads, junctions, slopes, bus stops and bends). On hilly stretches, special efforts should be taken to ensure that heavy traffic will run smoothly even at night. In the case of intermittent, sectional sanding, it should be discontinued on straight and level stretches of the road in such a way that the drivers will be able to notice it well in advance. If the traffic volume is below 1 500 vehicles per day, the sand should cover an area in the middle of the road as wide as the width of the sanding machine. Both lanes are to be sanded only if the traffic volume exceeds 1 500 vehicles per day.

Maintenance classes Isk, Is and I

Actions to prevent slipperiness should, at the latest, begin when the friction factor is determined or estimated to be below 0,30. All attempts should be made to keep the roads clear of snow and ice all through the winter by ploughing, grading and salting. A mixture of salt and sand can be used when the temperature of the road surface falls below -5°C, and pure salt treatment does not work, or when the salt liquid freezes.

A road is considered to be in target condition 4 when the wheel tracks are bare on an area 88 cm wide, and the friction factor as well as the thickness of the packed layers of snow meet the standards.

Maintenance class II

Actions to prevent slipperiness should, at the latest, begin when the friction factor is determined or estimated to be below 0,25.

In the case of paved surfaces, salt should be spread on the roads during the autumn and spring seasons. Salt and sand mix should be used when the temperature stays continuously below zero, and layers of compressed ice and snow develop. On the most difficult road sections, from a traffic point of view, salt can be used throughout the winter.

On unpaved surfaces a mixture of salt and sand, or pure sand, should be used, depending on the situation. If the temperature stays below -5°C continuously, no sand is normally applied. If, however, the minimum friction factor is not sustained due to a combination of increased temperature, humidity and traffic, the most dangerous stretches of the road should be sanded. If really slippery conditions are expected to

develop due to a change in weather, the whole stretch of the road may be sanded.

Maintenance class III

Actions to prevent slipperiness should, at the latest, begin when the friction factor is determined or estimated to be below 0,15.

The action taken should include sanding with mixed salt and sand, or with pure sand. It the friction factor falls only slightly below 0,15, the stretches of road most dangerous from a traffic point of view should be sanded. If the friction factor becomes considerably lower, the whole stretch of the road should be treated.

When attempting to prevent slipperiness with sand, only a single strip in the middle of the road, the width of the sand distributor, should be treated. Both lanes are to be sanded only if the traffic volume exceeds 1 500 vehicles per day.

Maintenance class IV

The action taken to prevent slipperiness should, at the latest, begin when the friction factor is determined or estimated to be below 0,25.

On roads designated for pedestrians and bicycles, only sand without salt should be used. Normally these ways are sanded along the whole stretch, but intermittent, sectional sanding may be used depending on the weather conditions.

A strip along a pedestrian and bicycle lane may be left unsanded for other modes of traffic, such as sledges. The width of such a strip would normally represent a third of the width of the lane, and be located along the outer edge of the road as seen from the main carriageway.

2.3. Methods of winter road maintenance

Snow-ploughing

To organise the snow-ploughing work, a snow removal route plan should be compiled (*appendix 4*). It should focus mainly on a routing strategy for the snow-ploughs. The purpose of the plan is to select the right number of machines, the right types of snow-ploughs and working methods to such effect that every ploughing unit will be able to take care of its part of the job within the stipulated lead time for action.

Even before the frost sets in, all roads should be equipped with edge markers. They are posted to make it easier for the driver to judge the width of the carriageway, and to prevent over-ploughing beyond the edge or into curb-stones or similar narrowing obstacles that may jeopardise snow-ploughing. On straight sections the distance between the markers should be around 100 metres, and in bends about half that distance. Over-ploughing is defined as ploughing beyond the edge of the road, which may lead to other vehicles skidding off the road.

All necessary overhaul and alterations to the equipment should be carried out before the snow-ploughing season. During the winter season appropriate servicing and exchanging of worn parts should mainly be

taken care of by the individual driver himself. Snow-ploughs and related equipment should be checked and serviced immediately each time after they have been in use.

The drivers should make allowances for other traffic on the road, be cautious with regard to all kinds of constructions and structures related to the road, and adjust their speed according to the prevailing conditions, to minimise the risk of causing damage. Furthermore, they should beware of protrusions in the road surface, snow-free patches and special structures, which may be damaged, or in turn cause damage to the plough or truck.

The snow-ploughing of roads with a single lane in each direction should be undertaken in such a way that the middle of the road is ploughed first, so that no dividing snow wall will be created along the centre line. Ploughing should then continue towards the edges. During a snowfall, only the actual carriageway should be cleared. Bus stops and shoulders should not be cleared until the snowfall has ended. It is recommended that busy bus stops be cleared every time.

In slushy conditions the accident risk increases ten-fold as compared to dry conditions, because the tyres are prone to slush planing. Due to the high accident risk, all slush should be cleared as fast as possible, especially from the middle of the road. In addition to a twin blade plough, an angled plough with a rubber blade, or a plane edged, underbody blade, or a grading blade, or a turning plough and the slush blades of a motor grader could be used. The choice of blades depends on the consistency of the slush and on the condition of the road. A rubber blade is the obvious choice if the slush is very watery and the paved road surface is otherwise even, but worn with wheel track furrows.

Snow piles along the edge of the road increase the risk of snow drifts developing on the carriageway. Snow piles build up easily along such sections of the road where snow-ploughing speeds have to be kept low. High snow piles prevent additional snow from being thrown clear to the sides by the plough, thereby diminishing visibility and obscuring traffic signs.

Traffic signs covered by snow have to be cleaned, and the damaged ones repaired as soon as possible.

In the spring the water melting from the snow piles and packed snow layers forms ice on paved roads when freezing, increasing frost damage to a gravel road surfaces. To prevent this problem a slush furrow should be ploughed along the verge of the shoulder. This furrow can be produced with the side plough of a truck or with a grader. Wherever pools have developed, drains should be made across the verge.

Grading

By grading the packed snow and ice patches on the carriageway, the snow and ice layers on the road surface are thinned or completely removed. In terms of timing, grading should take place within the lead time for action, when the condition of the road falls below its stipulated maintenance class standards. Dangerous wheel grooves, however, should be removed as soon as possible.

Hard packed snow should be removed with a motor grader. Softer variants are cleared by the underbody blade of a truck in connection with ordinary snow-ploughing. If a dented blade is used, the surface will become grooved, and if a pinned blade is used, it becomes rough, which improves road-holding.

Salting

Applying salt in temperatures around the freezing point is an effective method for preventing the road from becoming slippery, or for making it less slippery, and for preventing the snow from sticking to the surface. By salting well in advance accidents can be prevented during the first spells of cold weather in the autumn.

Salt should, in general, not be used when road surface temperatures fall below -7°C. The slush created by the salt should be removed as quickly as possible.

If granulated salt is spread dry, a large proportion of it is scattered beyond the carriageway due to the aerodynamic disturbances caused by the spreading unit itself and the surrounding traffic. Dry salt cannot be spread efficiently at speeds above 30 kilometres per hour and it is not suitable for preventive use.

The properties of adhesion to the road of pre-wetted salt are far better than those of dry salt. Wetting accelerates the melting process, especially under cold and dry conditions. Salt is wetted with a salt liquid. The liquid runs from a tank mounted on the platform of a truck, being mixed with the granulated salt at the rotary spreading disc or in a funnel just before it. The ratio of agent to salt is 0 to 30 per cent. If the spreader does not have this wetting facility, it is possible to use plain water as a wetting agent and to carry out the mixing on the platform. In this case, however, all the salt on the platform has to be spread onto the road. The approximate amount of water needed is 80 to 100 litres per cubic metre, depending on the type of spreader. It is important that the water is given enough time to seep into the salt.

Table 10. Quantity of pre-wetted salt to be distributed kg/km and g/m^2 over a 7-metre wide carriageway.

Temperature of road surface	Black ice, frost		Freezing rain		Freezing sleet		Snow fall	
	kg/km	g/m^2	kg/km	g/m^2	kg/km	g/m^2	kg/km	g/m^2
+...-2°C	14-35	2-5			70-175	10-25		
0...-7°C			35-140	5-20				
Variable							70-210	10-30

When spreading roads with liquid salt, the quantity of salt being scattered beyond the carriageway is small. Salt liquid is generally made of sodium chloride, but even a ready-mixed calcium chloride solution is quite suitable, if readily available. The sodium chloride content should be 23 to 26 per cent, and in the case of calcium chloride, approx. 32 per cent. If the concentrate is not strong enough, the attempt to combat slipperiness may

fail. Salt liquid is best for melting thin ice and white frost, and for use as a preventive treatment. It should not be used for melting thick ice or snow, as the concentration would gradually be diluted with water and lose its effect. When spreading salt during a snowfall, the carriageway should always be cleared at the same time.

Table 11. Recommended quantities of 25 % Sodium Chloride (NaCl) kg/km (for 7-metre wide carriageway) and g/m^2.

Temperature of road surface	Black ice, frost and runs kg/km	white melt g/m^2	Preventive salting kg/km	g/m^2	Snowfall and sleet kg/km	g/m^2	Slippery frost conditions kg/km	g/m^2
≥2°C	35-140	5-20	35-105	5-15				
ca 0°C					140-280	20-40		
- 15°C							70	10

Salting in advance is aimed at preventing ice from developing on the road surface, or snow from sticking to the surface. Salting with a salt liquid is the best alternative in this case, but if the traffic volume of the road is small, even pre-wetted salt would suffice. Preventive salting would improve the safety of main roads, especially under conditions of black ice. Reliable weather reports are extremely important for these measures to succeed. Preventive salting involves the use of pure salt or pre-wetted salt, if the snowfall has already begun, or the use of salt liquid if the work is carried out and completed before the snowfall.

Concrete structures, such as bridges, have to be rinsed in the spring to prevent the advance of corrosion caused by mixed deposits of dirt and salt. As corrosion advances under warm weather conditions, it is recommended that this be carried out promptly at the first opportunity in the spring.

Sanding

Sanding is usually used for sectional spot treatment, which means that only slopes, bends, junctions, and other hazardous places from the traffic point of view, are treated in this way. Only under exceptionally slippery conditions should a complete stretch of the road be sanded. Narrow roads should be treated only along a strip in the middle; wider roads should have both lanes sanded.

The sanding media should consist of the most economical, readily available material complying with the required standards. Normally one refers to sand, road metal or similar types of crushed stone material. The maximum particle size is 8 millimetres, but on roads with slight traffic volumes sand of up to 16 millimetre particles may, in exceptional cases, be used. An exceptional case would include heavy rain, which would flush away any smaller particles.

The appropriate sanding quantity is 150 to 350 grammes per square metre, or the equivalent of 0,3 to 0,5 cubic metres per kilometre of road, applied in one lane. Smaller amounts would be needed for thin films of ice, whereas a

somewhat more generous amount of sand would be required in the more hazardous sections of the road.

To make sand manageable under winter storage conditions, and to make it adhere better to the road, it should be mixed with 15 to 20 kilogrammes of salt per cubic metre. The mixing should take place prior to storage, or immediately before use. If large quantities are involved, the amounts of salt should be measured carefully. The storage mounds of sand should be made high and non-compact to prevent icing.

Natural sand, gravel, road metal or similar sand qualities with a particle size of 0 to 10 millimetres can be used for sanding. Diagram 1 shows the recommended qualities.

In terms of its properties, the best salt-sand mixture is obtained by mixing it already in the autumn. Then the material can well be stored either in a storage or in mounds outdoors. The latter should be covered and stored in such a way that the salt solution cannot escape into the underlying soil.

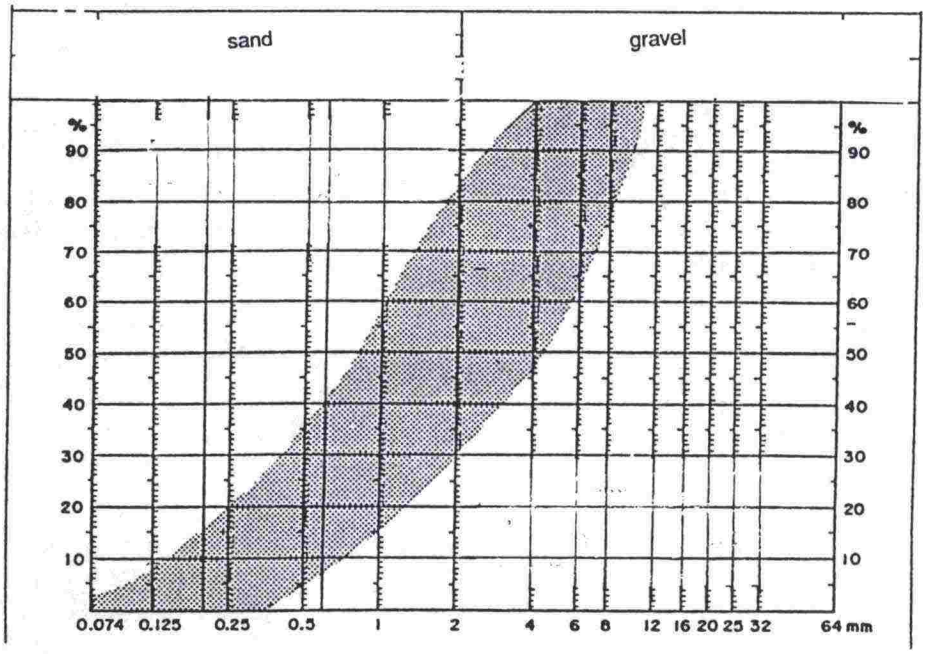

Diagram 1. Recommended particle sizes of sanding material.

2.4. On call and standby system during the winter season

Systems of staff being on call or on standby as dictated by the weather can be arranged in several ways. The crucial factor is with what certainty one wants to guarantee that maintenance work is carried out to stipulated standards outside normal working hours, e.g. at night and during weekends. The following is one solution:

One supervisor or foreman at a time is on call for the duration of one week, and will be watching the weather at home after normal working hours.

The drivers are divided into three teams according to availability. In the case of the Istra organisation, each team consists of eight drivers, which implies that six snow-ploughing trucks and two graders are available at any one time, even at night and during weekends. Experience will show whether the drivers should be divided into two teams only.

One member of the team that is available at any time is on night duty between 11 p.m. and 7 a.m. The person on night duty observes the weather and reports any probable changes to the supervisor or manager on call. The latter decides whether the standby force should be called on duty. In addition to weather-watching, the person on night duty performs other tasks, either at the base or on the road. Thanks to lesser traffic volumes during the night, it is an effective time for carrying out preventive salting and sectional spot sanding. The supervisor or foreman calls the man on night duty in the evening, giving him instructions for the night's work.

An example of the standby system used by the Jyväskylä Maintenance Area has been described in a memoranda in the context of this project. A similar system is also recommended for Istra.

2.5. Various other types of work

Maintenance of the drainage system

The objective of the drainage system is to divert rainwater or melted water from the carriageway or the section of the road, and to keep the roadbed reasonably dry. The maintenance of lateral ditches, roadside and outlet ditches, as well as culverts, is an important task.

With regard to open ditches, it is important to remove obstacles to the natural flow of water, and to make sure that the ditch retains its intended inclination. The lateral ditches should be sufficiently deep to keep the section of the road free of surface water, thereby preventing it from flooding the carriageway and damaging its surface. The water should flow via the lateral ditches into the outlet ditch away from the road area.

The work should be carried out during the summer or, in case of soft ground, during the winter when the soil is frozen. An excavator is used for digging and planing, either from above the ditch or from its side. In even sections where the soil is soft, a ditch blocked by mud or vegetation can be cleared with the aid of a ditch plough fitted to a grader.

Ridges of dirt accumulating under protective barriers must be removed to allow the water to drain off. Where necessary, the mud deposited in culverts under the road has to be removed during the summer season. In the winter, a frozen culvert has to be cleared by melting a hole through the ice with steam from a hose.

The quality target for good maintenance of a drainage system is that the water escapes into the ditch, and that the flow in the ditch is sufficiently unrestricted.

Traffic sign maintenance

The texts and symbols on all traffic signs should be maintained according to accepted standards. Their overall condition should, at least, be kept on a satisfactory level. The signs should be clearly visible and correctly positioned.

In the summer the traffic signs should be cleaned with water and a brush, and in the winter frozen dirt should be removed with hot water or steam. For this purpose a light truck or a van equipped with traffic sign washing appliances and, when necessary, a steam generator, should be used.

The condition of traffic signs may be classified verbally and illustrated with the aid of exemplifying photographs. A proper traffic sign should have only minute damage to it, the colours should not be faded, it should be clean, and the post should be close to vertical. A badly maintained sign displays a fair amount of damage, which makes it difficult to read, the colours have either faded or become darker, the sign or symbol is faulty, it is covered in dirt or snow, and the post is leaning over.

Maintenance of the gravel shoulder

The purpose of the gravel shoulder is to support the carriageway and to give the driver an opportunity to pull over with his vehicle and stop out of the way of on-coming traffic on the carriageway. The condition of the shoulder affects both safety and, among other things, the quality of road maintenance during the winter season.

Basically, maintenance of the shoulder involves keeping it even and level with the carriageway, firm and free of dust. It is kept in shape with the help of a road-grader. Bumps are graded off and hollows have to be filled in with additional gravel. Dust is transfixed by spreading calcium chloride on the road in the spring and, if necessary, even in the summer.

The shoulder is in a good condition, if it is level with the carriageway, firm and even. Conversely, the shoulder is in a bad shape, if the elevation shows divergences of more than 3 centimetres, if it is bumpy and its edge is covered with scattered clods and vegetation, which would prevent an unrestricted flow of water, and if the shoulder is in danger of collapsing under the volume of a heavy vehicle.

The best solution would be to pave the shoulder in asphalt level with the carriageway, but with the necessary inclination outwards to let the water drain from the road.

3. DETERMINING REQUIRED RESOURCES

3.1. Machines and vehicles

The assessment of the number of machines and trucks required is based on the road maintenance classifications, accepted quality standards and working methods to be applied. The objective is to ensure a virtually round-the-year usage, and to have manpower substituted with machines to the highest possible extent.

Trucks

The basic machine for main road maintenance is a truck with sufficient power. It should be fitted with a hydraulic system enabling at least two, preferably three auxiliary machines to operate independently at the same time. This would ensure effective operation, especially in view of winter maintenance, which to a large extent dictates what resources are required.

The possibility of operating several auxiliary devices simultaneously means that various maintenance operations can be carried out in one run as, for instance, snow-ploughing with the front and side ploughs, slush clearing with the underbody blade together with sanding or salting. This implies further that the engine power of the truck has to exceed 200 kW, and the capacity of the hydraulic system 100 to 150 litres per minute, if three power outlets are to be served simultaneously.

The basis for assessing the number of trucks needed is that the accepted maintenance class quality is achieved within the appropriate lead time schedule. In Finland the resource calculations are currently based on the premise that one truck will manage 60 kilometres of main road. In the case of Istra one has to take into account that no privately owned machinery is available, which means that Istra's own fleet of machinery has to take care of all the roads. Furthermore, the roads in Istra are winding and built to a smaller scale than the main roads in Finland, which means that the machinery will operate at lower road speeds.

An example of snow-plough routes, containing a specific plan for Istra, has been compiled (*appendix 4*). The calculations are based on the assumptions that the a road speed of the maintenance vehicles is 30 kilometres per hour on single carriageway road, whereby roads wider than 14 metres (and a paving width of at least 7.5 metres) have been included as dual carriageways. The results would suggest a need for 5 trucks. The snow-clearing route plan, however, is compiled for 6 trucks.

In the example in question, it has been assumed that Sisu trucks are to be used, two of which will be acquired for Istra. Other roads would be maintained by Kamac or Ural truck units. Four of these would be needed, fitted with equipment as specified below.

Motor graders

Road grading machines can be used in the winter mainly to remove bumps in the road caused by packed ice or snow, and in the summer to level dirt roads and to prepare roadbeds for asphalt. The winter is the decisive factor in the calculation of resources required. There are only 3

kilometres of gravel or dirt road in Istra, and the gravel shoulders are not very wide.

A grader is needed in the summer, when laying new asphalt, as the work is preceded by levelling of the road bed and reshaping and improving the longitudinal and transversal profiles of the road.

Using side wings and underbody blades mounted on trucks in the winter will reduce the need for an expensive grader. Thus, one grader would suffice even in the winter, instead of the existing three, providing that it is also equipped with a side wing. During periods of peak demand the grader should be run in two shifts.

Excavator

It is expected that an excavator will be needed for the maintenance of the drainage system in the summer. The problem is to find work for it during the cold season. There is no real use for an excavator in the winter, as it is far too clumsy for tasks such as loading snow. The obvious solution is to have a wheel tractor equipped with a bucket loader and an excavator bucket. The excavator bucket would be used for the maintenance of lateral ditches, for grading and clearing the ground around culvert openings, and similar work related to the drainage system. The bucket loader would be needed for loading snow, sand etc. As it runs on wheels, it will be easy to move from one site to another.

The tractor equipped with a bucket loader and an excavator bucket can also be used for ploughing roads with low traffic volumes, the courtyard of the base etc.

The tractor should have four-wheel-drive and be as large and powerful as possible for operation efficiency.

Other machines and trucks

A light duty truck fitted with a hydraulic lifter would be very useful for the maintenance and cleaning of traffic signs and road barriers, as well as for other sanitary work. Furthermore, it would also be an effective device for spreading salt solution in the future. In addition, and partly for the same usage, one should have a van, preferably of the type fitted with a hydraulic lift mounted on a short open platform behind an extended cabin. It would also be useful for the transportation of workmen.

A wheel loader, equipped with gravel and snow buckets and a coppice cutter, would possibly also be needed.

3.2. Ancillary equipment

Snow-ploughs

The guiding principle should be that the ploughs fit most available machinery, such as the trucks and tractors, and that they are hydraulically operated. *Table 12* shows ploughs suitable for use in combination with trucks.

Table 12. Types of snow ploughs attachable to trucks.

Type	Description	Ploughing width (m)
One-way front plough	Angled 35-40°, front mounted	2.8...3.0
Double-blade plough	Angled 35-40°, front mounted, 2 blades.	2.8...3.0
Telescopic plough	Angled 35-40°, front mounted, extendable	2.8...3.5
Articulated plough	Blade angle 35-40°	
Reversible plough	Blade angle adjustable	3.0...4.0
Yard cleaning plough	Blade angle adjustable	
Slush plough	For clearing slush, not packed snow	2.8...3.0
Side wing plough	Adjustable, extends the ploughing width	0...1.5
Underbody blade	For levelling packed humps of snow, mounted under the vehicle	

In principle, all these snow-ploughs would be suitable for the needs of Istra. The best working width is achieved by installing a combination of both front mounted plough and side wing. For clearing snow and slush, a front mounted double-blade plough should be used. Thus the working width would cover up to 4.5 metres, which would suffice to clear the paved surface of even the widest type of carriageway (max. 9 m) providing that two parallel runs are made. A double-blade plough at the front may also be used without a side wing. A underbody blade mounted below the chassis of the truck is an efficient way to level bumps caused by packed snow or ice, and it reduces the need to employ a grading machine.

It is recommended that the Sisu trucks should be fitted with a double-blade plough, underbody blade and side wing plough. The Kamac (or Ural) trucks should have an one-way plough up front, and a grading blade underneath.

A snow-plough and snow-bucket loader should be mounted on the tractor excavator. One grader should have a side wing.

Sanding equipment

The total quantity of sand used in 1993 to sand the roads was approx. 12 500 cubic metres. The development plan aims to substitute most of this sand with salt on the roads with high traffic volumes, as this would be considerably more efficient, the spreading would be faster and the material consumption lower. In the future, sand would mainly be used on roads with a traffic volume of less than 1 500 vehicles per day.

Today there are mainly three types of devices for spreading sand: the sand spreading trailer, the roll shaft type spreader and the spinner spreader. For sand and salt-sand mixtures the roller spreader, combined with a salt solution mixing device is the preferred alternative.

The sanding capacity using sand or a mixture of sand and salt is 30 to 40 kilometres per hour. In addition to that, the driving time to the site, loading time, as well as the time needed for starting up and finishing the operation should be considered. Realistically, one should reckon with the following figures: With an operation time of 4 hours according to the stipulated maintenance quality level, one sand spreading unit can cover approx. 80 kilometres, when the total length of the road network to be maintained is 100 to 120 kilometres. This capacity figure relates to sanding equipment mounted on the Kamac (or Ural) trucks.

Salt spreaders

For salt spreading, the recommended equipment is the spinner spreader combined with a salt wetting device. Such equipment would guarantee that the salt consumption can be adjusted and kept at its optimum every time salt spreading is undertaken.

The speed at which a truck can spread salt is approx. 40 kilometres per hour. Depending on the prevailing temperature and the season of the year, the amount of salt required is 30 to 120 kilogrammes per kilometre. If the salt is of fine granular size, the required quantity will increase by 10 to 20 per cent. One truck load of salt should suffice for over 100 kilometres of road along a single strip in one direction. Two salt spreading units should be able to manage the road network in Kolomna within an operation time of 2 hours. The salt spreading units should be fitted on the Sisu trucks.

Miscellaneous ancillary equipment

Two of the trucks, the light duty truck and the van should be fitted with hydraulic lifters to enable mechanical lifting of various objects.

Other necessary ancillary equipment would include a coppice cutter and mower. A wheel loader, a grader or a tractor could be used as its drive unit.

For measuring the level of slipperiness, there are friction meters available for installation in passenger cars. Initially, only one such gauge should be obtained. The need for additional units can be assessed later.

Each truck, grader, combined bucket loader and excavator tractor, light duty truck and wheel loader should be equipped with car radio telephones (ARP) for internal communication. The supervisors should be supplied with portable sets; an estimated quantity of 4. The total number of telephones needed would be at least 15.

The necessary ancillary equipment for the light duty truck and the van would include a pressure washer in both for the cleaning of traffic signs and road barriers.

Later on, the acquisition of a steam generator should be considered for opening culverts and for washing traffic signs.

Regarding the sand for sanding, the aim is to obtain good quality, screened material. If this cannot be obtained, the acquisition of a sand screening device should be contemplated. It should be possible to purchase it jointly with nearby Avtodors.

This organisation do not take care of the painting of road markings on the carriageway. Also the sweeping of the carriageway is not included in this paper.

3.3. Repair and maintenance of machinery and trucks

Regular and thorough maintenance of all machinery and trucks is necessary to ensure economic and reliable performance. The basic principle should be that the drivers wash their own machines and trucks, and take part in the maintenance operations, at least by assisting the mechanic.

A minimum of two mechanics are needed as repair and maintenance staff, and they should be skilled in welding to be able to mend broken ploughs etc. Likewise, they should be familiar with all lubrication jobs. Finally, the mechanics should serve as reserve drivers.

3.4. Staff

The primary rule is that the personnel should possess multiple skills.

The number of truck drivers required should be determined on the basis of 3 drivers per truck. In this way they can take turns at being on standby and step in, in the event of illness, vacations etc. In principle each light duty truck should have one regular driver. Thus, 19 truck drivers will be needed. Other drivers required are:

2 drivers for the tractor excavator and the wheel loader
2 drivers for two graders

Thus a total of 23 drivers would be needed.

The drivers assist the mechanics in repair and maintenance work. The drivers are "ear-marked", which means that each machine and truck has been designated to one specific driver, who has one or two co-drivers. This should ensure that there will always be one person in charge of each vehicle. It is one way of keeping the machine or truck in a better condition. In addition, the designated driver will learn how to operate several units of auxiliary equipment simultaneously, which is the basis for an efficient operation.

Besides driving his own truck or machine, a driver should learn to drive other vehicles as well. A driver should be a true professional in road maintenance, and under supervision he should be able to carry out other tasks beside driving a machine or truck.

Two mechanics are required for the machines and trucks as listed in paragraph 3.3. They would also serve as reserve drivers when needed.

In the office one supervisor, aided by two clerks, i.e. a total of 3 employees, are needed. One of the clerks should serve in a secondary capacity as the warehouse manager's assistant and deputy.

In addition to the manager, an estimated number of 3 supervisors will be needed, totalling 4 management level employees.

One warehouse manager is needed, and one of the clerks will serve as his stand-in and assistant.

This adds up to a total staff requirement of 33 people for the maintenance of the road network of Istra. In addition, it is estimated that 10 employees will be needed to run the heating plant and to handle the security. There will thus be a total of 43 employees.

3.5. Materials and their storage

Salt and sand

It is recommended that a storage should be erected in close connection to the base, or at least at a reasonable distance from it. It should be equipped with a waterproof floor, which would allow escaping saltwater to be collected. Such a facility would make it possible to store sand, salt and a sand-salt mixture. The following are storages of this type:

An arch storage covered in a fabric such as trevira, or other plastic.
An arch storage with laminated wood beams and wood used as covering material.
A steel storage with walls of plastic-clad sheet steel.
A silo excavated into the rock.
A storage excavated into the rock and fitted with a concrete roof.

A storage or a silo excavated into a rock is filled from above, which makes the filling process easy and fast. For loading a truck, it is driven into a tunnel leading to the dispensing gates beneath the silo. A rock silo is the only alternative that does not require a separate loader. With the other types of storage, a loader would be needed, both for filling the store and loading the trucks. It would therefore be sensible to have the storage situated in the immediate vicinity of the maintenance base, where the loader is normally stationed.

It is recommended that a storage be built specifically for the storage of sand and salt, dimensioned for a capacity of 2 000 to 3 000 cubic metres. Thanks to the improved methods of snow-clearing, and the introduction of salt spreading with a mixture of pre-wetted sand and salt, it is estimated that the consumption of spreading material will be reduced to one third, perhaps even to one fourth, of the present consumption.

4. ACTION AND ACQUISITION PROGRAMME

Equipment acquisition

The table on the next page contains a summary of the equipment required on the base of the above mentioned working methods and practices. Costs in USD are given at a realistic level and will become more precise as tenders are received.

Some of the equipment can be acquired and used jointly, for instance with other Avtodors. These include brine (salt liquid) production unit, belt conveyors for sand, as well as for sand and salt mixture. The joint acquisition, with one or two avtodors, of a screening plant for sand, which is more effective and expensive than the auxiliary equipment attached to a tractor or wheel loader, could also be considered (USD 45 000 to 50 000).

Estate of base

The base is rather well situated with regard to the roads to be maintained. The necessary investments for the base are

- storage facility for sand, salt and salt-sand mixture
- a building for office premises, including changing, washing and dining facilities
- facilities for servicing and repair of machinery
- storage facilities for machinery, motor vehicles and ancillary equipment, including heated and cold premises
- a fuel distribution facility.

The anti-skid treatment materials storage is estimated to require a space of 2 000 to 3 000 m^3. The most reasonable solution would be a concrete foundation and PVC-covered arched beams or a plastic clad sheet steel structure. Environmental factors should be considered due to the handling of salt. The materials store is estimated to cost USD 100 000 to 120 000. (FIM 1 = 350 rubles, USD 1 = FIM 5.3).

The planning of the base is a separate project. It was estimated in connection with the present project that the new base will cost in the region of USD 1 million. The size of the investment will be essentially influenced at the planning stages. The final and exact cost estimate will be known after tenders have been received.

Machine, vehicle or device	Quantity	Unit price (USD)	Total (USD)	Notes
Truck Sisu	2	130 000	260 000	Sisu
Truck, Kamac	4	20 000	80 000	
Grader	1	180 000	180 000	Vammas
Excavator-loader	1	75 000	75 000	Valmet
Light truck	1	10 000	10 000	Gaz etc.
Van	1	10 000	10 000	Russian
Double-blade plough	2	8 000	16 000	For Sisu trucks
Underbody blade	6	7 000	42 000	For trucks
One-way front plough	4	6 000	24 000	For Kamac
Side wing	3	6 000	18 000	For grader and Sisu trucks
Snow bucket	1	2 000	2 000	For excavator-loader
Snow plough	1	3 000	3 000	For excavator-loader
Sand spreader	4	7 000	24 000	For Kamac
Salt spreader	2	10 000	20 000	For Sisu trucks
Coppice cutter and mower	1	20 000	20 000	For wheel loader or grader
Wshing device	1	6 000	6 000	For trucks or vans
Truck hoist	2	5 000	5 000	For truck
Skid-resistance tester	1	1 000	1 000	For passenger vehicle or van
ARP telephone network			100 000	For machines and base
Steam generator	1	20 000	20 000	
Sand screening device	1	18 000	18 000	Ancillary device for tractor or wheel loader

5. CONSEQUENCES OF DEVELOPMENT PLAN

Financial consequences

Based on the present operational model, the number of employees would exceed 100, and according to this plan the figure is 33, if only the actual road maintenance staff are included, or about 43, if the staff and security guards of the heating plant are included.

The operating costs of machinery and motor vehicles (fuel, repairs and service, spare parts) are expected to be cut down by a half as the numbers are reduced. The consumption of sand will reduce to less than one third of its present level, and that of salt will be reduced by one third. The combined financial effect of these factors is estimated at 200 million rubles annually, or USD 100 000 to 110 000.

From the point of view of the provider of maintenance services alone, a full return on these investments is expected in 3 to 5 years. Depending on the type of equipment and the method of operation and maintenance, the useful life of the equipment ranges from 6 to 12 years. Full returns on the materials store investment are expected in about 30 years in respect of the foundations, and in 20 years in respect of the roofing. With regard to the base building, a return on the investment may take about 35 years. It usually pays to carry out a minor renovation after about 20 years.

Environmental effects

The new working methods will have the following effects on the environment:

1. The consumption of sand will be cut down to one third from its present level. Thus the nuisance of dusty conditions, especially in the spring, will be reduced. Less sand will also enter the drainage system. The reduced use of materials will lessen the exploitation of sandy ridges and other natural resources.
2. The use of salt will be reduced by 20 to 35 per cent from the present level, which implies less of a burden on the environment on the verges and in close proximity of the roads, including many areas under cultivation.
3. Fuel consumption will be reduced by a half from its present level, which will have a favourable effect on the quality of the air in the district.

The effects on the road users

The road users will experience the new working methods and techniques, as well as the well defined quality level as follows:

1. Improved quality with regard to the winter maintenance of roads. A cost saving will be achieved in terms of a drop in the accident rate and the associated expenditure, to a lesser extent in terms of time saving, as well as motor vehicle maintenance and repair costs.
2. Traffic safety will be boosted by improved shoulders, etc.

6. OTHER DEVELOPMENT PROPOSALS

Other development proposals include the following:

1. *Training.* The adoption of the new working methods and new type of equipment and auxiliary devices necessitates extensive training of operating personnel. The vocational skills of the employees, and their potential to manage the tasks delegated to them, will only be boosted by continued, long-term training. In addition to technical information, the training shall include attitude formation aspects. The categories of staff to be mentioned in particular in the context of training include the foremen and supervisory staff, drivers, and the machine and motor vehicle mechanics and service staff.

2. *Asphalt.* The durability of the existing road surfacing can be enhanced considerably by improving the proportions of the asphalt mix and by using good quality raw materials as ingredients in the mix.

3. *Road profile.* When building or improving a road, attention should be paid to the profile of the road. All the built layers of the road have to be of the right profile in terms of latitude and smoothness for the end result to be good. Suitable working methods shall be developed for renewing the wearing course so that the profile of the road can be easily improved. The form and evenness of the road layers in profile have a bearing on the drainage, road safety and the quality of road maintenance - even in winter - as well as the durability of the road.

4. *Shoulders*. The gravel surface shoulders and the drainage system, and their maintenance were discussed in Section 2.5 above. An uneven, dusty verge of loose consistency and not level with the road is a problem as far as road maintenance, drainage and safety are concerned. The best method is to resurface the dirt or gravel covered shoulder with asphalt, unless the said disadvantages can be eliminated otherwise.

5. *Drainage*. Drainage was also discussed above in Section 2.5. A functioning drainage system will affect the durability of the road structure and ruts, freezing of the road surface, and road safety.

6. *Maintenance base.* Planning of the Istra maintenance base.

7. *Cellular telephone network.* According to preliminary studies, a general cellular (NMT) telephone network will not be built in the Istra region in the next few years. It is therefore recommended that a private car radio phone network (ARP) be built, from which the general telephone network can be accessed.

8. *Quality standards*. The creation of a general quality standard system is recommended for road maintenance, covering the Istra district, the general area of Mosavtodor and all of Russia, as it would facilitate the supervision of work, and ensure even quality.

In addition to winter maintenance (ploughing, anti-skid treatment), it would, among others, cover the drainage system, gravel shoulders, traffic signs, pavement, landscape gardening, cleaning and lay-byes. The standards comprise a classification system, for example 1 to 5, and a verbal description and illustrations, whenever necessary, of the quality requirements for each class. The standards should be uncomplicated, realistic and manageable. The strategic management of road maintenance involves defining the quality classification required for roads of different classes.

9. *Summer road maintenance.* It would be good to prepare a development plan similar to the present report, but focussed on road maintenance in the summer.

10. *Contracting.* One aspect of this development is to improve the conditions for competition and contracting. It involves measuring and defining the division between work to be done in-house and that contracted out, determining work loads, measuring the quality, selecting the party or parties to carry our the work, and the contract documents.

11. *Communication and information.* This subject is important, even if not among the first developmental priorities. Road maintenance plays an important role in the development of business, industry and the society in general. As the road maintenance authority ultimately serves the road user, making general information available and accessible to the public is a key factor.

7. REFERENCES

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8. APPENDICES

1. The Location of Istra.

2. Roads in the Istra Area

3. Recommendation for a the Maintenance Classification of Roads

4. Recommendation for Snow Plowing Routes

5. Contact persons

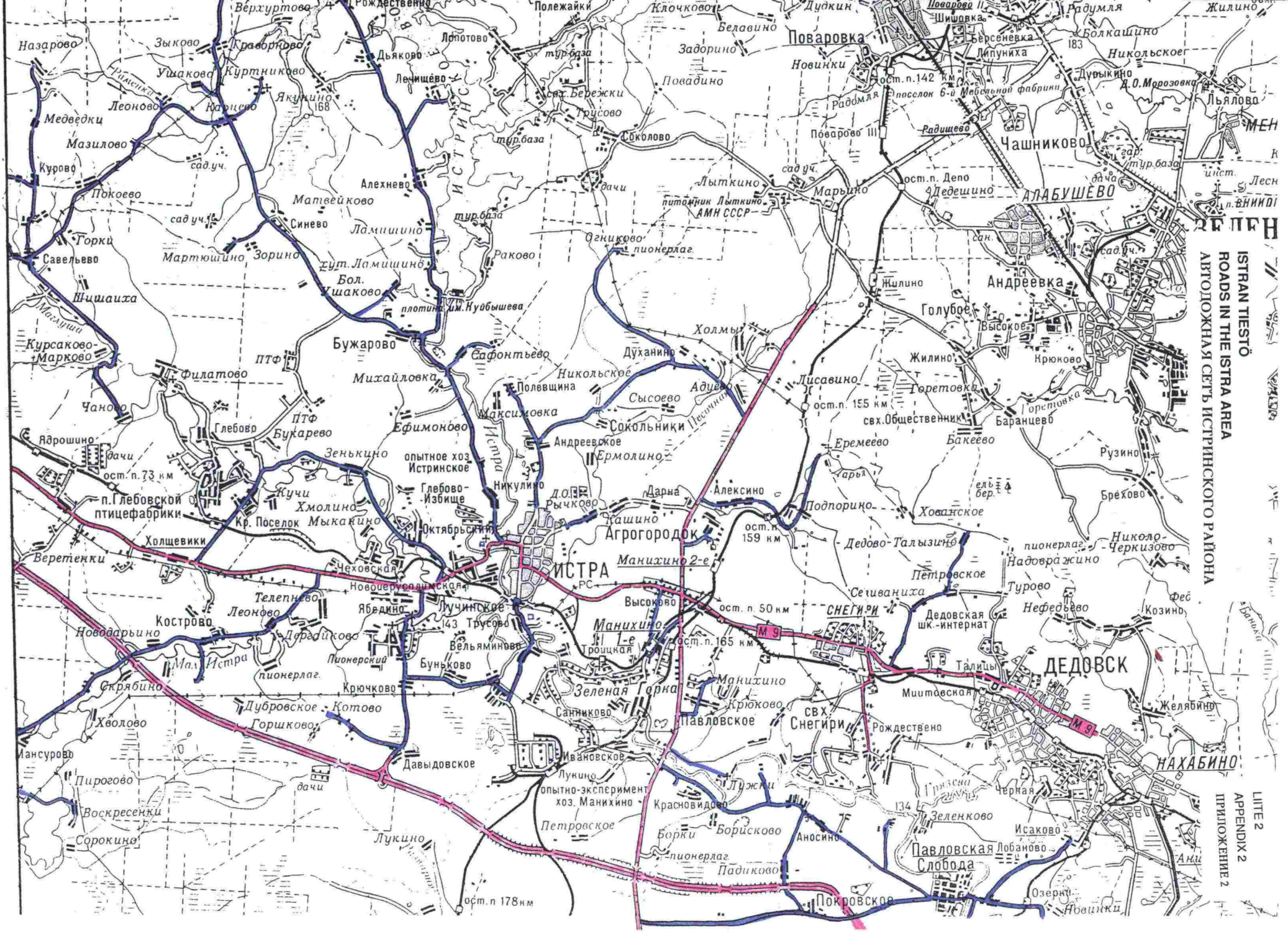
8.1 Supplementary memoranda

The following additional memoranda were produced in Finnish and Russian to supplement this project

1. Road maintenance resources now and 15-20 years ago in the Jyväskylä Maintenance Area.
2. Example of Winter Road Maintenance Plan, Jyväskylä Maintenance Area.

LIITE 1
APPENDIX 1
ПРИЛОЖЕНИЕ 1

Istran ja Kolomnan sijainti
The location of Istra and Kolomna
Местоположение Истринского и Коломенского районов

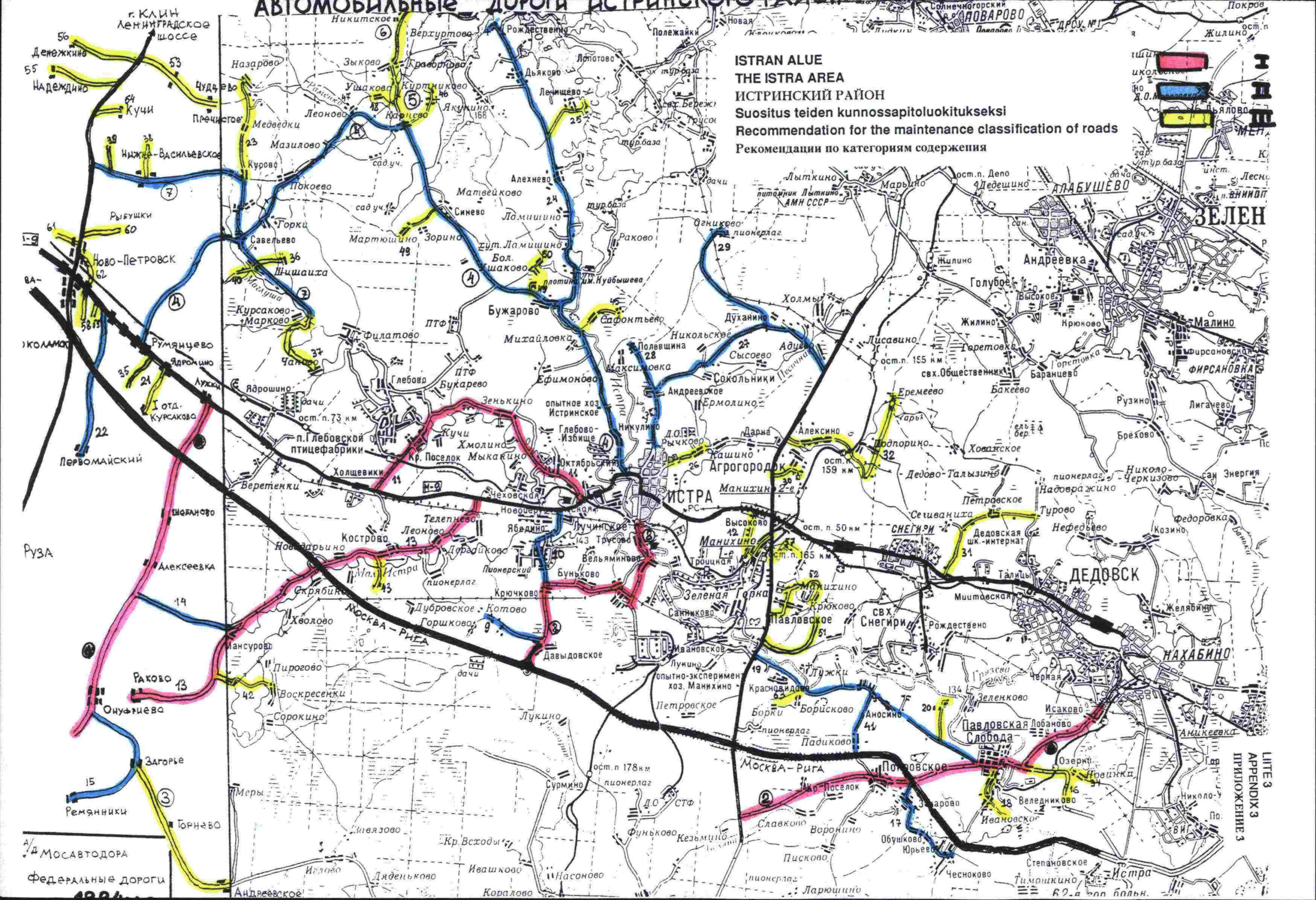

ISTRAN TIESTÖ
ROADS IN THE ISTRA AREA
АВТОДОРОЖНАЯ СЕТЬ ИСТРИНСКОГО РАЙОНА
LIITE 2
APPENDIX 2
ПРИЛОЖЕНИЕ 2
ИСТРА
РС
Агрогородок
Манихино 2-е
Манихино 1-е
Манихино
Зеленая Горка
Поваровка
Чашниково
АЛАБУШЕВО
Андреевка
ДЕДОВСК
НАХАБИНО
Павловская Слобода
Покровское
Снегири
Бужарово
Костров
Давыдовское
Ивановское
Павловское
Сокольники
Ермолино
Дарна
Алексино
Подпорино
Дедово-Талызино
Петровское
Турово
Нефедьево
Козино
Желябино
Рождествено
Миитовская
Дедовская шк.-интернат
Голубое
Высоково
Крюково
Жилино
Лысавино
Баранцево
Рузино
Брехово
Николо-Черкизово
Надовражино
Хованское
Еремеево
Бакеево
Горетовка
Лыткино
Марьино
Дедешино
Ново-Дарьино
Скрябино
Хволово
Пирогово
Воскресенки
Сорокино
Лукино
Борки
Борисково
Аносино
Падиково
Исаково
Лобаново
Озерки
Новинки
Зеленково
Черная
Грязна
Красновидово
Петровское
Опытно-эксперимент. хоз. Манихино
Санниково
Крючково
Дубровское
Котово
Горшково
Трусово
Вельяминово
Буньково
Пионерский
Яковлево
Лучинское
Телепнево
Леоново
Новоиерусалимская
Чеховская
Октябрьский
Кр. Поселок
Мыканино
Кучи
Хмолино
Холщевики
Веретенки
Зенькино
Ядрошино
Глебово
Чаново
Филатово
Курсаково-Марково
Шишаиха
Мартюшино
Зорино
Горки
Савельево
Покоево
Курово
Мазилово
Медведки
Леонов
Ушаково
Зыково
Назарово
Верхуртово
Рождественно
Дьяково
Лечищево
Якунино
Карцево
Куртниково
Кравотино
Матвейково
Синево
Ламишино
Алехнево
Раково
Огниково
Сафонтьево
Михайловка
Ефимоново
Полевщина
Никольское
Максимовка
Сысоево
Адуево
Духанино
Холмы
Никулино
Рычково
Глебово-Избище
Опытное хоз. Истринское
Полежайки
Клочково
Белавино
Задорино
Новинки
Повадино
Трусово
Соколово
Раздмля
Посёлок 6-й Мебельной фабрики
Никольское
Дудыкино
А.О. Морозовка
Льялово
Болкашино
Радумля
Шишовка
Берсеневка
Липуниха
Дудкин
Жилино
Высокое
Крюково
Сечиванихa
Ново-Иерусалимская
Телепнево
Леонов
Ябедино
Лучинское
Трусово
Вельяминово
Буньково
Пионерский
Дубровское
Котово
Горшково
Санниково
Крючково
Зеленая Горка
Манихино
Павловское
Свх. Снегири
Рождествено
Миитовская
Дедовская шк.-интернат
Талицы
Турово
Нефедьево
Козино
Желябино
Петровское
Сечиванихa
Надовражино
Николо-Черкизово
Брехово
Рузино
Баранцево
Горетовка
Лысавино
Еремеево
Бакеево
Подпорино
Хованское
Дедово-Талызино
Алексино
Дарна
Ермолино
Сокольники
Песочный
Андреевское
Никольское
Полевщина
Максимовка
Сысоево
Адуево
Духанино
Холмы
Ефимоново
Михайловка
Бужарово
Сафонтьево
Ламишино
Матвейково
Алехнево
Раково
Огниково
Лытково
Марьино
Дедешино
Чашниково
Поваровка
Новинки
Задорино
Белавино
Клочково
Полежайки
Дьяково
Лечищево
Якунино
Карцево
Куртниково
Кравотино
Ушаково
Зыково
Назарово
Верхуртово
Рождественно
Медведки
Мазилово
Курово
Покоево
Горки
Савельево
Шишаиха
Курсаково-Марково
Филатово
Чаново
Ядрошино
Глебово
Букарево
Зенькино
Кучи
Хмолино
Мыканино
Холщевики
Веретенки
Костров
Ново-Дарьино
Скрябино
Хволово
Пирогово
Воскресенки
Сорокино
Лукино
Давыдовское
Ивановское
Лукино
Опытно-эксперимент. хоз. Манихино
Красновидово
Петровское
Борки
Борисково
Аносино
Падиково
Павловская Слобода
Покровское
Исаково
Лобаново
Озерки
Новинки
Зеленково
Черная
Грязна
Лужки
Пионерлаг.
Питомник Лыткино АМН СССР
Турбаза
Свх. Березки
Свх. Общественник
Ост. п. 73 км
Ост. п. 155 км
Ост. п. 159 км
Ост. п. 165 км
Ост. п. 142 км
Ост. п. 50 км
Ост. п. 178 км
Ост. п. Депо
Пост. Поварово III
Пост. Поварово
Радищево
Плотина им. Куйбышева
Пионерлаг.
Дачи
Сад уч.
Гар.
Инст.
Ферма
Бани
Ель
Бер.
Ручей
Песочный
Истра
Малая Истра
Маглуша
Ламишинское
Большое Ушаково
Истринское
Истринское
Истринское
М 9
143
168
183
134

LIITE 3
APPENDIX 3
ПРИЛОЖЕНИЕ 3

Suositus teiden kunnossapitoluokitukseksi
Recommendation for the maintenance classification of roads
Рекомендации по категориям содержения

Tienumero Road number № дороги	Pituus (km) Length (km) Длина участков (км)	Liikennemäärä (KVL) Traffic volume (ADT) Приведенная интенсивность движения (авт/сут)
Luokka 1 / Class 1 /		Категория 1
1	13,0	3002
2	16,2	1872
8	9,7	1523
11	12,2	1985
13	17,7	1611
Sum 1	**68,8**	
Luokka 2 / Class 2 /		Категория 2
4	33,3	1180
5	2,6	705
7	14,1	439
9	2,6	383
10	3,6	1253
14	2,6	973
15	7,5	397
17	4,1	459
19	10,5	1368
22	4,4	359
24	12,2	1464
27	12,4	1027
28	1,8	313
29	5,5	407
41	3,5	365
Sum 2	**120,7**	

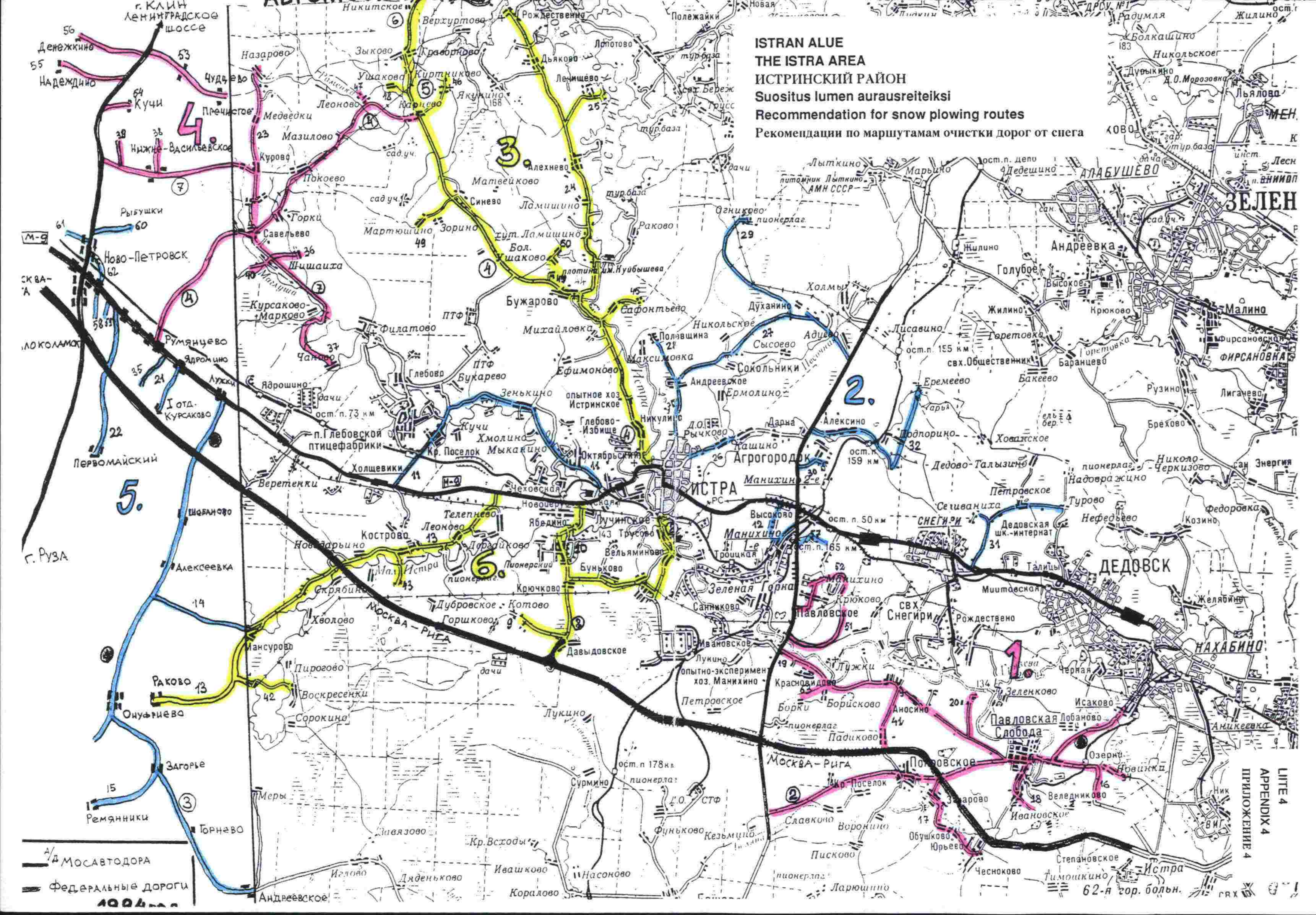
Tienumero № дороги	Pituus (km) Длина участков (км)	Liikennemäärä (KVL) Покрытие
Luokka 3 / Class 3 /		Категория 3
3	7,9	< 200
6	5,2	< 200
12	2,3	< 200
16	3,0	< 200
18	1,5	< 200
20	1,8	< 200
21	2,1	< 200
23	3,8	< 200
25	2,0	< 200
26	0,7	< 200
30	0,8	< 200
31	5,4	< 200
32	8,3	< 200
33	0,3	< 200
34	1,0	< 200
35	2,0	< 200
36	3,2	< 200
37	3,0	< 200
38	0,5	< 200
39	1,0	< 200
40	0,8	< 200
42	2,8	< 200
43	2,3	< 200
44	0,9	< 200
45	0,9	< 200
46	1,6	< 200
47	0,6	< 200
48	1,5	< 200
49	1,8	< 200
50	1,9	< 200
51	2,5	< 200
52	4,4	< 200
53	2,2	< 200
54	0,4	< 200
55	1,5	< 200
56	1,5	< 200
57	1,9	< 200
58	1,5	< 200
59	0,6	< 200
60	1,0	< 200
61	0,5	< 200
62	1,5	< 200
63	1,1	< 200
Sum 3	**91,5**	
Sum 1,2 3	**281,0**	



ISTRAN ALUE
THE ISTRA AREA
ИСТРИНСКИЙ РАЙОН
Suositus teiden kunnossapitoluokitukseksi
Recommendation for the maintenance classification of roads
Рекомендации по категориям содержания
I
II
III
LIITE 3
APPENDIX 3
ПРИЛОЖЕНИЕ 3
А/Д МОСАВТОДОРА
Федеральные дороги
г. КЛИН ЛЕНИНГРАДСКОЕ ШОССЕ
ИСТРА
ДЕДОВСК
НАХАБИНО
СНЕГИРИ
Москва-Рига
Руза
Ново-Петровск
Румянцево
Онуфриево
Павловская Слобода
Агрогородок
Бужарово
Савельево
Первомайский
Покровское

LIITE 4
APPENDIX 4
ПРИЛОЖЕНИЕ 4

ISTRAN ALUE
THE ISTRA AREA
ИСТРИНСКИЙ РАЙОН
Suositus lumen auraustreiteiksi
Recommendation for snow plowing routes
Рекомендации по маршрутам очистки дорог от снега



LIITE 5
APPENDIX 5
ПРИЛОЖЕНИЕ 5

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Jaakko Rahja
Einari Poikonen
Nikolai Van
Vasilij Ananiev
Victor Yashin

Слева направо:
Михаил Клиницкий
Яакко Рахъя
Еинари Поиконен
Николай Ван
Василий Ананьев
Виктор Яшин